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Forward link power control in cellular system using NT/IO values

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A system and method is taught for controlling the power level of transmissions within a communication system having a base station, a mobile station, a communication channel, and a pilot channel. The mobile station determines a signal strength value according to a communication signal received by way of the communication channel. A pilot channel signal is determined according to a pilot signal transmitted by way of the pilot channel. The signal to noise ratio of the communication signal is determined according to the determined signal strength value and the pilot channel signal. The power level of a transmission is controlled according to the signal to noise ratio. The noise level in a communication channel within the communication system is estimated. The pilot channel signal includes pilot energy and pilot noise components.; The pilot energy component is removed to provide a remaining pilot signal. Communication system operations are controlled according to the remaining pilot signal. The power levels of transmissions are controlled by determining the signal to noise ratio of a signal within the communication channel and determining a difference signal. The difference signal is formed by determining the difference between determined and desired signal to noise ratios. The difference signal is transmitted between the base station and the mobile station. The pilot channel has at least one frame and the power control signal is inserted into the frame. Thus, information representing the strength of the communication signal is transmitted to the base by way of the pilot channel within the frame. The pilot channel can have two information frames for transmitting the power control signal a plurality of times.

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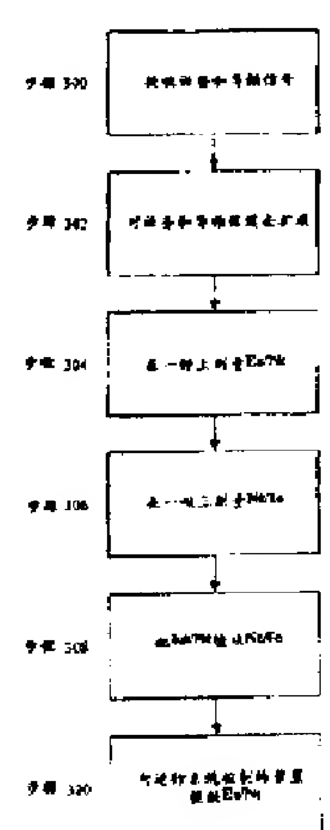
[54]发明名称 蜂窝系统中利用Nt/Io值的前向链路功率控制

[57]摘要

本发明教授了在通信系统中控制发送功率电平，该通信系统 具有基站、移动 站、通信信道和导频信道。移动站根据通信信道上接收到的通信 信号确定信号强度值。根据导频信道上发送的导频信号确定导频信道信号。根据确 定的信号强度值和 导频信道信号确定通信信号的信噪比。根据该信噪比控制发送 的功率电平。估计通 信系统中的通信信道内的噪声电平。导频信道信号包括导频 能量和导频噪声分量。除去导频能量分量，提供余下的导频信号。根据余下的导频信号 控制通信系统的操 作。通过确定通信信道中的信号的信噪比和确定差信号控制传 输的功率电平。通过 确定所确定的和所希望的信噪比之间的差值形成差信号。该差 信号在基站和移动站 之间传输。导频信号至少具有一帧，功率控制信号插入到 该帧。因此，把表示通信 信号强度的信息通过该帧内的导频信道发送给基站。导频信道可以具有两个信息帧，以多次发送功率控制信号。



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权 利 要 求 书

1、一种确定在包括通信信道和导频信道的通信系统中接收到的信噪比传输的方法，其特征在于，包含下列步骤:

(a)在预定时间量上测量每个码元信号/干扰比;

(b)在第二预定时间量上测量噪声/干扰比;

(c)把测得的每个码元信号/干扰比除以测量噪声/干扰比; 以及

(d)向网络控制器提供该商。

2、一种在通信系统中控制发送功率电平的系统，该通信系统具有基站、移动站和多个包括通信信道和导频信道的信道; 其特征在于，该系统包含:

(a)根据通信信道接收到的通信信号由移动站确定的信号强度值;

(b)根据导频信道发送的导频信号确定的导频信道信号;

(c)根据信号强度值和导频信道信号确定的通信信号的信噪比; 以及

(d)发射机，根据信噪比控制发送功率电平。

说　明　书

蜂窝系统中利用 N_T/I_O 值的前向链路功率控制

技术领域

本发明一般涉及一种通信系统，尤其涉及通信系统中的功率控制。

背景技术

已有技术中有许多通信系统需要测量移动站接收到的信号的强度。例如，在移动站从一个基站到另一个基站的切换期间，要确定移动站接收到的信号的强度，以便确定什么时候进行切换。在名称为“CDMA 蜂窝通信系统中移动站协助的软切换”的美国专利 No. 5,267,261 中揭示了这样一种切换技术，该专利已转让给本发明的受让人。

在美国专利 6,267,261 的改进的技术中，移动站监视系统中邻近基站发射的导频信号的信号强度。移动站通过该移动站正在通信的基站向系统控制器发送信号强度报文。利用响应于信号强度的从系统控制器到新基站和移动站的的命令报文而建立通过新基站和当前基站的通信。移动站检测对应于移动单元当前正在通信的至少一个基站的导频信号的信号强度低于预定电平的时间。移动站通过其正在通信的基站向系统控制器报告表示相应基站的测量信号强度。从系统控制器到识别出的基站和移动站的命令报文断开通过相应基站的通信，而使通过另一个或一些基站的通信继续。

已知，把移动站发射的功率控制信息插入到与话务信道分开的专用控制信道内。然而，仍希望减少对分开的控制信道的需求。此外，虽然最后把在话务信道上发送的信号能量功率用于确定功率控制参数，但是已知控制信息是基于差错率而不是信噪比，这是因为话务信道的信噪比难以测量。例中如，在目前的一些系统中，差错之间的时间用来指定差错率。然后把差错率用来确定话务信道的质量。而且，这难以获得功率控制信息，并及时地把它用来响应于功率控制信息中指出的情况。

发明内容

本发明教授了一种利用导频信道上表现出的噪声的计算量来估计话务信道上提供的功率相对量的系统和方法。这种估计可以用于几个目的，包括控制具有基站、移动站和包括通信信道和导频信道的多个信道的通信系统内的发送功率电平。移动站测量接收到的每个码元的能量值与接收到的干扰量之比。在导频信道上接收到的能量值用来确定在导频信道上接收到的噪声量。根据确定的信号强度值和导频信道噪声值来确定通信信号的信噪比。因而，在揭示的方法和装置的一个实施例中，发送的功率电平是根据计算得到的信噪比来控制的。

本发明还教授了一种在通信系统中估计通信信道内的噪声电平的系统和方法。导频信号包括导频能量分量和导频噪声分量。从导频信道信号中除去导频能量分量，提供余下的导频信号。如上所述，根据导频信道中的噪声量来估计信道中的噪声量。

如上所述，系统是根据打算接收的装置接收到的功率量的指示来控制发送的信号功率。在这种系统中，发送的功率电平是通过确定接收到的信号的信噪比与所希望的信噪比之间的差值来控制的。发射机发射基站与移动站之间的差信号。

把导频信道在时间上分成帧，然后把功率控制信号插入到每帧。因此，表示通信信号强度的信息通过每帧中的导频信道发送给基站。

附图概述

从下面结合符图的详细描述，本发明的特征、目的和优点将变得更明显，图中，相同的参照符号在所有图中表示相应的部分：

图 1 示出了蜂窝通信系统的典型示图；

图 2 示出了图 1 的蜂窝通信系统中的功率控制子信道；

图 3 是确定接收到的话务信号的信噪比进行的步骤的流程图；

图 4 是图 3 中一些步骤的详细流程图；以及

图 5 是被揭示装置的框图。

本发明的实施方式

图 1 提供了蜂窝通信系统的典型示图。图 1 所示的系统可以使用各种多址调制技术，以便于大量的系统移动站(或移动通信装置)之间以及基站之间的通信。这些技术包括 CDMA 频谱扩展调制。

在典型的 CDMA 系统中，基站在相应的导频信道上发送独特的包括导频载波的导频信号。例如，根据被揭示的方法和装置的一个实施例，导频信号是未调制的、直接序列的扩展频谱信号，在所有时间上，由每个基站利用公共的伪随机噪声(PN)扩展码发送。导频信号除了提供相干解调的相位基准和信号强度测量的基准之外，还可以使移动站获得初始系统同步。而且，接收到的导频信号可以用来估计接收到的话务信号的到达时间、相位和幅度。根据被揭示的方法和装置的一个实施例，每个基站传输导频信号是用具有不同的码相位偏移的同一个 PN 扩展码来调制的。

系统控制器 10，也称为移动交换中心(MSC)10 一般包括接口和处理电路，向基站提供系统控制。控制器 10 还控制从网络(例如公共交换电话网(PST N))到适当基站的通信设备呼叫的路由，以传输给适当的移动站。移动站通过基站到 PSTN 的路由也由控制器 10 来控制。

控制器 10 可以利用各种装置，例如专用电话线、光纤链路或微波通信链路耦接到基站 12、14、16 上。在图 1 中，示出了三个基站 12、14、16 和通信装置(例如移动站)18。移动站 18 至少由接收机、发射机和处理机组成。基站 12、14、16 一般包括控制基站 12、14、16 的功能的处理电路和与移动站 18 和系统控制器 10 通信的接口电路。

图 1 中的箭头 20A-20B 表示基站 12 和移动站 18 之间可能的通信链路。图 1 中的箭头 22A-22B 表示基站 14 与移动站 18 之间可能的通信链路。同样，图 1 中的箭头 24A-24B 表示基站 16 与移动站 18 之间可能的通信链路。

在移动站 18 处理了接收到的信号之后，得到的信号是所要的信号与噪声信号的组合。在一时间周期上的平均信噪比是接收到的信号强度的较好度量。例如，在 CDMA 系统中，接收到的信号的信噪比可以是在一块上的平均。因此移动站 18 可以估计信噪比，并把该估计与移动站 18 的实际接收值进行比较。根据被揭示的方法和装置的一个实施例，移动站 18 向基站 12、14、16 发送信噪比值的测得值与期望值之间的差值，作为参数(FWD_SNR_DELTA)(以分贝为单位)。该参数(FWD_SNR_DELTA)最好在反向链路功率控制子信道上发送。

在确定期望信噪比时，移动站 18 计算信噪比，这将产生等于由基站 12、14、16 构成的正向链路基本块擦除率的平均正向链路基本块擦除率。在计算期望信噪比时，移动站 18 假设以低于每个 PN 码片的功率的三分贝来传输连续较低的速率块。根据被揭示的装置的一个实施例，移动站 18 接收路径的最大组合比。

除了计算期望信噪比之外，移动站 18 必须确定接收到的话务信号的信噪比。图 3 的流程是较高层的流程，它示出了为确定接收到的话务信号的信噪比所进行的步骤。起初，接收话务和导频信号(与该信道上的噪声一起)(步骤 300)。虽然滤波器除去了其频带(在该频带上可以传输话务和导频信号)之外的噪声，但是带内的噪声仍能通过。利用用于复用话务信道的特定的 Walsh 码对接收到的话务信号去覆盖(decover)。同样，利用用于复用导频信道的特定 Walsh 码对导频信道去覆盖(步骤 302)。一旦导频和话务信道被去覆盖，则估计每个码元信号对干扰比，E_S/I_O(步骤 304)。接着测量噪声/干扰，N_t/I_o(步骤 306)。一旦测得了这些值，用 N_t/I_o 来除每个码元信号/干扰，E_s/I_o 以各出每个码元对噪声比 E_s/N_t(步骤 306)。然后把该值提供给使用该每个码元噪声比 Es/Nt 来控制系统(例如对正向链路发送信号进行功率控制)的设备(步骤 310)。至于步骤 304 和 306 如何进行的详细描述则在图 4 中的流程图中描述。

本技术领域的熟练人员应当理解，为了去覆盖以分离出正交信道，每个话务信道必须包括在导频信道的噪声中。同样，除了所关心的话务信道之外，导频信号和每个话务信道都要包括在所关心的话务信道的噪声中。一旦完成了去覆盖，则话务信道内的噪声仅包括与非正交信号相关的能量。本技术领域的熟练人员应当理解，一般用自动增益控制装置来确保接的总接收信号基本上为恒值。因而，所有信号值都与总接收信号强度 I_o 有关。然而，这在下面的公式中没的标注出。因此，总接收话务信号可以表示成:

$$r_T=s_T+n_T \qquad \text{公式(1)}$$

其中，sT 表示所希望的话务信号，nT 表示接收到的话务信号中的噪声。应当理解:

$$s_r = \Sigma d_k E_{s,k}{}^{1/2} \qquad \text{公式(2)}$$

其中，dk 是话务信号中码元流或数据流中第 k 个码元；$E_{T,K}$ 是码元上的话务信道总接收能量。计算所有 k(从 1 至 n)之和，其中，n 是一帧内的码元总数。应当注意，在被揭示的方法和装置的另一个实施例中，码元数 n 可以与一帧内的码元数不同。

在许多情况下，使用“瑞克”接收机来组合从不同源接收到的信号或从同一个源接收到的但具有不同传播路径的信号(因此，彼此有延迟)。在这些情况下，通过把在每个独立的路径上接收到的话务信号乘相关的导频信号获得总接收话务信

号。该乘法使得每个接收到的话务信号被相关导频信号的相对强度加权。然后把这些乘积相加形成总接收话务信号 r_T。下面的公式表示该和：

$r_T = \Sigma r_{T,i} \langle r_{P,i} \rangle$　　　　公式(3)

其中，在从 1 至 m 的下标 i 上求和，$r_{T,i}$ 是第 i 条路径上的接收话务信号，m 是路径总数，包含了项 $r_{p,i}$ 的括号指示导频信号可以被低通滤波器滤除，以减少导频信号幅度在短时间上的波动。

特定路径的总接收导频信号可以被表示成：

$I_{P,i}=S_{P,i}+n_{P,i}$　　　　公式(4)

其中 S_p 表示接收导频信号，N_p 表示导频噪声。

此外，导频信号值 $S_{p,i}$ 等于数据乘以每个码元的能量 E_s 的平方根和换算系数。该关系可以被表示成：

$s_{P,i} = \alpha\Sigma(d_k E_{S,k}^{1/2})$　　　　公式(5)

其中，α 是换算系数，它考虑了话务和导频信道的相对传输增益以及每条信道的综合长度；在从 1 至 n 的下标 k 上求和；n 是码元总数；d_k 是导频信道的码元流或数据流中第 k 个码元；$E_{s,k}$ 是在第 k 个码元上的导频信道的总接收能量。码元流 d 基本上要么为正 1，要么为负 1，表示导频信道上调制的信息的状态。在导频信号的情况下，一般该数据为恒值 1。因此，数据 d 可以从该公式中除去。在把话务信号与导频信号相乘时，公式(2)可以代替公式(1)，公式(5)可以代替公式(4)。然后得到乘积：

$r_T = [(\Sigma d_k E_{S,k}^{1/2})_i + n_{T,i}] \cdot [\alpha\Sigma(d_k E_{S,k}^{1/2})_i + n_{p,i}] = d\alpha E_s +$ 噪声　　　　公式(6)

然而，如果导频信号的噪声 n_P 和话务信号的噪声 n_T 是不相关的，则乘积 r_T 基本上是话务数据乘以话务信号能量的经换算的无偏差的估计值。这是因为不相关的噪声将不求和。然而，相关数据要求和。因而，可以这样假设，噪声是可以可忽略的(即，是无关重要的，可以忽略)。有理由假设导频信号 r_P 的噪声和话务信号 r_T 的噪声 n_T 是不相关的，因为导频信号 r_P 和话务信号 r_T 是在正交信道上传输的。

由于 d 基本上是随机和未知的，因此，期望根据公式(6)来估计 d。根据被揭示的方法和装置，为了从公式(6)中除去 d，要进行点积。点积是在对接收话务信号解码和重编码之后，在估计值 d α ET 与码元流 d 之间进行的(步骤 400)。通过解码话务信息，基本上从接收信号中取出该信息。重编码信息把该信息返回到在解码之前存在的状态。由于数据序列在解码操作之后相对来说是已知的，所以进行这种

点积可以在确定接收信号的能量时考虑数据序列。即，点积把该数据投射到接收信号上。因而，对信息码元中的能量求和，而不是对噪声能量求和，因为噪声是不相关的。自然地，求和的码元越多，码元能量对噪声比越大。点积运算的结果是:

$\alpha E_T \cdot \alpha E_T = (\alpha E_T)^2$　　　　公式(7)

为了估计话务信道信号能量，从公式(7)除去换算系数α。换算系数可以表示成:

$\alpha = G_p/G_T \cdot L_p/L_T$　　　　公式(8)

其中，G_P是导频信号传输增益，G_T是话务传输信号传输增益，L_P是导频信号的累积周期，L_T是话务信号的累积周期。虽然导频累积周期L_P和话务累积周期L_T是已知的，但是在功率控制系数改变话务信道的增益的情况下，导频信号增益G_P和业务信号增益G_T之间的关系是未知的。

因此，为了估计换算系数α，移动站 18 通过计算导频信号与其本身的点积，确定导频能量。这产生了导频能量E_P的有偏估计，是信号能量的换算的有偏估计，$E_P = \alpha^2 E_T$。因此，话务信号能量E_T的有偏估计可以通过对无偏估计值(话务信号能量的αE_T)进行平方，然后把它除以导频信号能量的有偏估计值E_P来确定:

$E_T = (\alpha E_T)^2/(\alpha^2 E_T)$　　　　公式(9)

如公式(7)所注的，每个码元的能量E_s可以通过把E_T相对于码元进行归一化(即除以在其上确定E_T的码元数，例如每帧码元数)获得。因此:

$E_T/n=E_S$　　　　公式(10)

其中 n 是在其上确定E_T的码元数。

如果接收话务信号的基本块率是已知的(步骤 404)，则选择与该块率相关联的归一化点积(步骤 406)。然而，如果基本块率是未知的(步骤 404)，则选择具有最大值的点积(步骤 408)。

被揭示的方法和装置具有这样的优点，即导频信号具有已知的恒数据序列。由于数据序列是已知的，所以导频信道信号可以容易地区分出，以分开噪声内容(步骤 410)。根据被揭示的方法和装置的一个实施例，这是这样来完成的，即反转导频信道，相对于未偏移的导频信道信号，在时间上把被反转的导频信道信号偏移一个码元，把经偏移和反转的导频信道信号与未偏移的导频信道信号相加。也可以这样来完成，用 Walsh 码 W_{64}^{128} 对导频信道进行去覆盖，并在该帧上累积。这个特定的 Walsh 码是另一些正 1 和负 1 的图形。因此，导频信道内在离散码元数上的能量和

为零，因此，分离了其余的 N_T 项．这可以确定导频信道的归一化噪声。

所要的信噪比 E_S/N_T 的值可以简单地把 E_S 值除以值 N_T 来获得。

图 5 是被揭示的装置的简单框图．射频(RF)接收机 501 接收输入信号，并以已知的方式进行 RF 处理．然后把接收到的信号耦合给处理器 503 。处理器 503 中的 Walsh 去覆盖电路 511 对每个话务信道和导频信道进行去覆盖。本技术领域的熟练人员应当理解， Walsh 去覆盖电路 511 可以是在处理器 511 上运行的软件来实现，作为一个电路，或者利用分立元件来实现，或者与处理器 511 不同的专用集成电路(ASIC)来实现， 或者可以实现去覆盖过程的本技术领域已知的其它任何方式来实现。一当去覆盖，话务信道信号被耦合到解码器 507 ．类似于去覆盖电路，解码器 507 可以利用分立元件、与处理器 511 不同的专用集成电路(ASIC)或本技术领域内公知的可以实现解码过程的任何其它方式来实现. 解码处理得到由发送被接收信号的发射机原始编码的信息。然后把该信息耦合到再编码器 509 ．再编码器 509 可以利用分立元件、与处理器 511 不同的专用集成电路(ASIC)或本技术领域内公知的可以实现解码过程的任何其它方式来实现．一旦完成了重编码功能，则处理器 503 进行上述的确定 E_S/N_T 值的功能。然后把该值耦合给通信网控制器 505 ，例如基站内的用来控制正向链路功率控制的处理器，或者用来传送应当调整的正向链路功率控制量以维持所希望的传输功率的移动蜂窝电话内的处理器。应当注意，对 E_S/N_T 值的特定使用并不受到这里揭示的特定实施例的限制，而应理解，它可以包括对该量值的所有可能的应用。

移动站 18 也可以计算每帧基上的测得的归一化信噪比 E_f/N_t。测量归一化每帧信号干扰比 E_f/R，其中 R 是接收到的总信号， E_f是在信号帧期间所要的信号能量．然后测量每帧噪声干扰比 N_t/R 。 然后， 把 Ef/Io 除以 Nt/R 以计算 E_f/N_t．

可以如下计算用来计算归一化每帧信号的归一化每帧信噪比 E_f/N_o。可以对基本块的每种速率计算重编码码元 d 与软判定 d α E_T/I_o 的点积。可以对得到的结果进行平方，并除以估计的导频能量，其如下所示:

$$E_P / I_o = \alpha^2 E_T / I_o \qquad \text{公式(11)}$$

对基本块的每种速率的点积可以利用全速率块中的码元数对该块中的码元数之比来归一化。如果基本块速率未知，则可以选择最大归一化点积．然后在正向码信道内累加在该帧上的能量，可以测量每帧噪声干扰比 N_t/I_o。

表示信噪比的信号可以用来在本发明的系统和方法中控制功率传输电平．在

本发明的较佳实施例中，例如基站 12 、 14 、 16 可以使用移动站 18 发送给它的 FWS_SNR_DELTA 值。 FWS_SNR_DELTA 值通过移动站 18 在反向帧 n 的功率控制子信道上传送给基站，以调整正向增益(FWD_GAIN)，应用于正向帧 n+1 上。

为了计算 FWS_SNR_DELTA 值，移动站 18 可以与计算得到的信号/噪声值一起使用期望信号/噪声值。可以如下计算每帧期望信噪比 E_f/N_t。移动站 18 可以把初始期望值设置成等于成功解码的第一基本块的速率。如果基本块被擦除，则移动站 18 增加期望值 E_f/N_t。否则，移动站 18 减小期望值 E_f/N_t。

利用所要的正向链路基本块擦除率 R_e 和 E_f/N_t 的最大增加率确定增加步长 P_i 和减少步长 P_d。该增加的最大速率可以定义成 P_m。则 $P_d=(R_eP_m)(R_e-1)$和 $Pi=(P_d/R_e)$ 的值可以是一半。

如果基站 12 、 14 、 16 没有擦除功率控制子信道 FWS_SNR_DELTA ，则正向每码元信噪比Δ标记(FWS_SNR_DELTA)被置为 1 。否则，基站 12 、 14 、 16 把 FWS_SNR_DELTA 和 FWD_SNR_VALID 值都设置成 0 。然后如下计算由基站发射机加到正向传输帧 n+1 上的正向增益:

$$FWD\_GAIN[n+1]=\begin{cases} FWD\_GAIN\_MIN, & \text{其中 } FWD\_GAIN_{adj}<FWD\_GAIN\_MIN \\ FWD\_GAIN\_MAX, & \text{其中 } FWD\_GAIN_{adj}>FWD\_GAIN\_MAX \\ FWD\_GAIN_{adj}; & \text{其它情况} \end{cases} \quad \text{公式(12)}$$

其中， $FWD\_GAIN_{adj}=FWD\_GAIN[N]*10^{-X}$，上标 X 根据 FED_SNR_DELTA 和 FWD_SNR_VALID 确定。然而，应当理解，根据本发明的系统和方法，任何计算 FWD_GAIN 的方法都可以使用。

现在参照图 2 ，图 2 示出了一部分功率控制子信道 30 。功率控制子信道 30 适用于图 1 的通信系统。例如功率控制子信道 30 可以用来从移动站 18 向基站 12 、 14 、 16 发送 FWD_SNR_DELTA ，以控制向移动站 18 的发送功率电平。

功率控制子信道 30 可以位于载送多个功率控制组 34 的导频信道内。例如 16 个功率控制组 34 可以在导频信道内形成多个帧 38 中的每个帧。每个功率控制组 34 可以包含多个伪随机噪声字 38 。在实现本发明的方法时，可以除去一个或多个伪随机噪声字 38 ，用功率控制信息 40 代替。

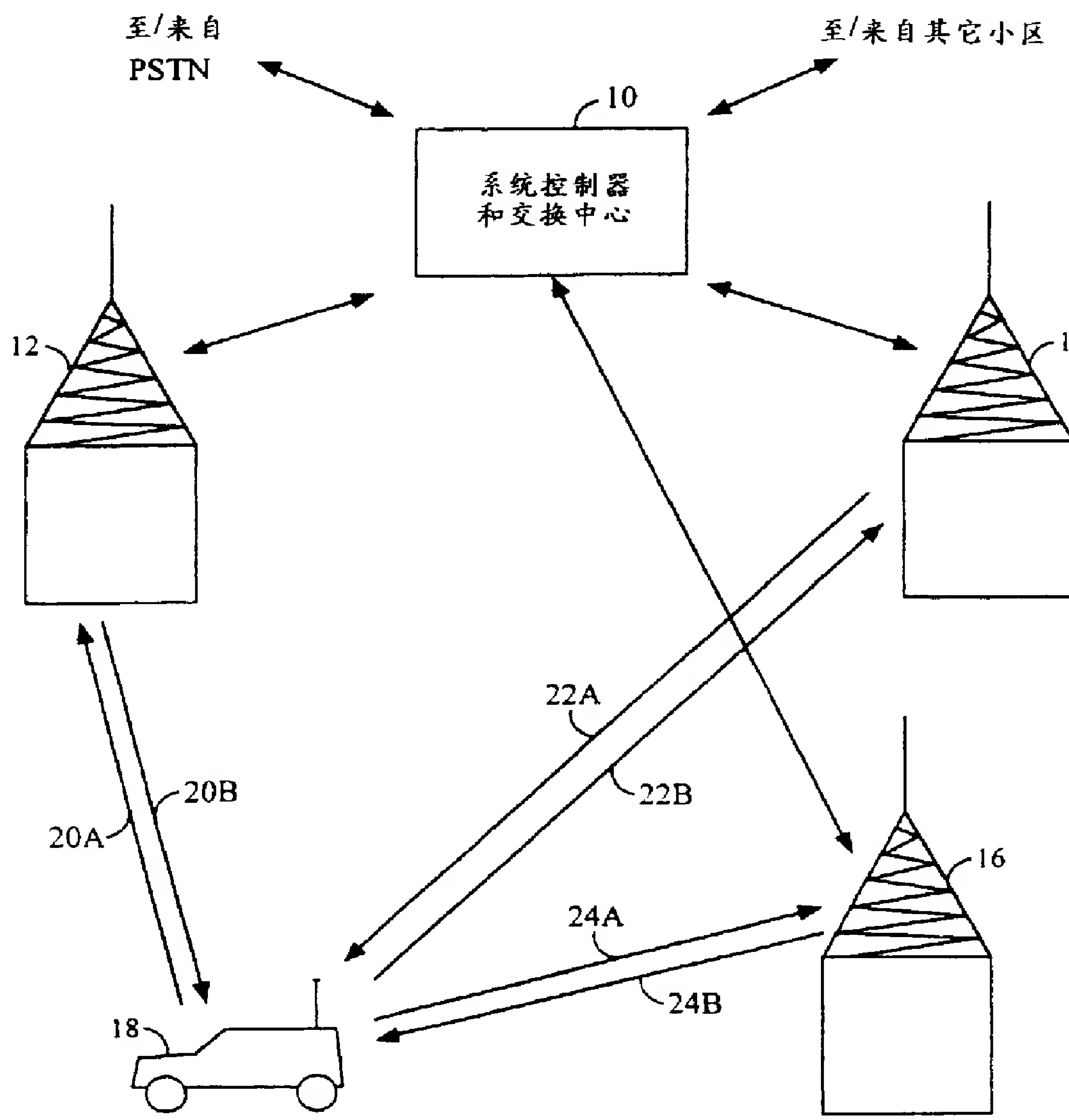
被除去的伪随机噪声字 38 可以是功率控制组 34 长度中的任何噪声字 34 。然而，在较佳实施例中，使用了位于功率控制组 34 的中心之前的噪声字 38 。较佳地，如公式(12)所示，功率控制信息 40 指示发射机增加或减小发送功率电平一指定的

量，或者保持发送功率电平不变。而且，以这种方式重复几次发送包含功率控制信息 40 的帧 38 以提高可靠性也是较佳的。

应当理解，把功率控制信息插入到功率控制组 34 中所选择的位置上可以发送任何功率控制信息。此外，还应理解，把功率控制信息插入到导频信道的这种方法可以有利地应用于前述的确定功率控制信息的任何方法中。

已提供了本发明的较佳实施例的描述，它可以使本技术领域的熟练人员制作或使用这里要求保护的本发明。本技术领域的熟练人员无需创造性劳动能容易地对这些实施例进行改变，并可以把描述的原理应用于其它实施例。因此，本发明不局限于上面揭示的具体实施例的限制，而应是与这里揭示的原理和新颖特征一致的最宽的范围。

说 明 书 附 图



至/来自
PSTN
至/来自其它小区
10
系统控制器
和交换中心
12
14
22A
22B
20B
20A
16
24A
24B
18

图 1

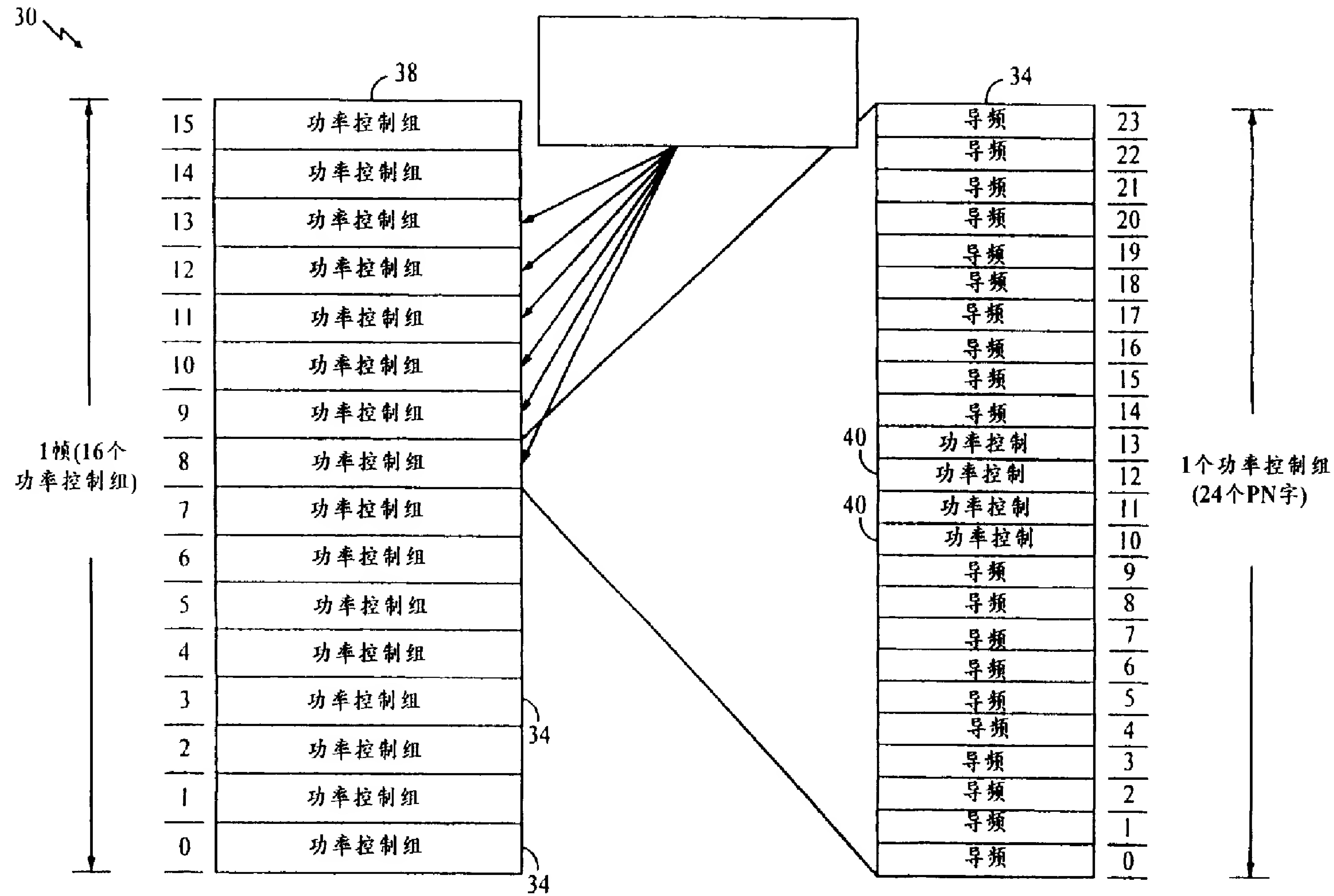

30
38
34
1帧(16个
功率控制组)
15 功率控制组
14 功率控制组
13 功率控制组
12 功率控制组
11 功率控制组
10 功率控制组
9 功率控制组
8 功率控制组
7 功率控制组
6 功率控制组
5 功率控制组
4 功率控制组
3 功率控制组
2 功率控制组
1 功率控制组
0 功率控制组
34
34
34
导频 23
导频 22
导频 21
导频 20
导频 19
导频 18
导频 17
导频 16
导频 15
导频 14
40
功率控制 13
功率控制 12
40
功率控制 11
功率控制 10
导频 9
导频 8
导频 7
导频 6
导频 5
导频 4
导频 3
导频 2
导频 1
导频 0
1个功率控制组
(24个PN字)

图 2

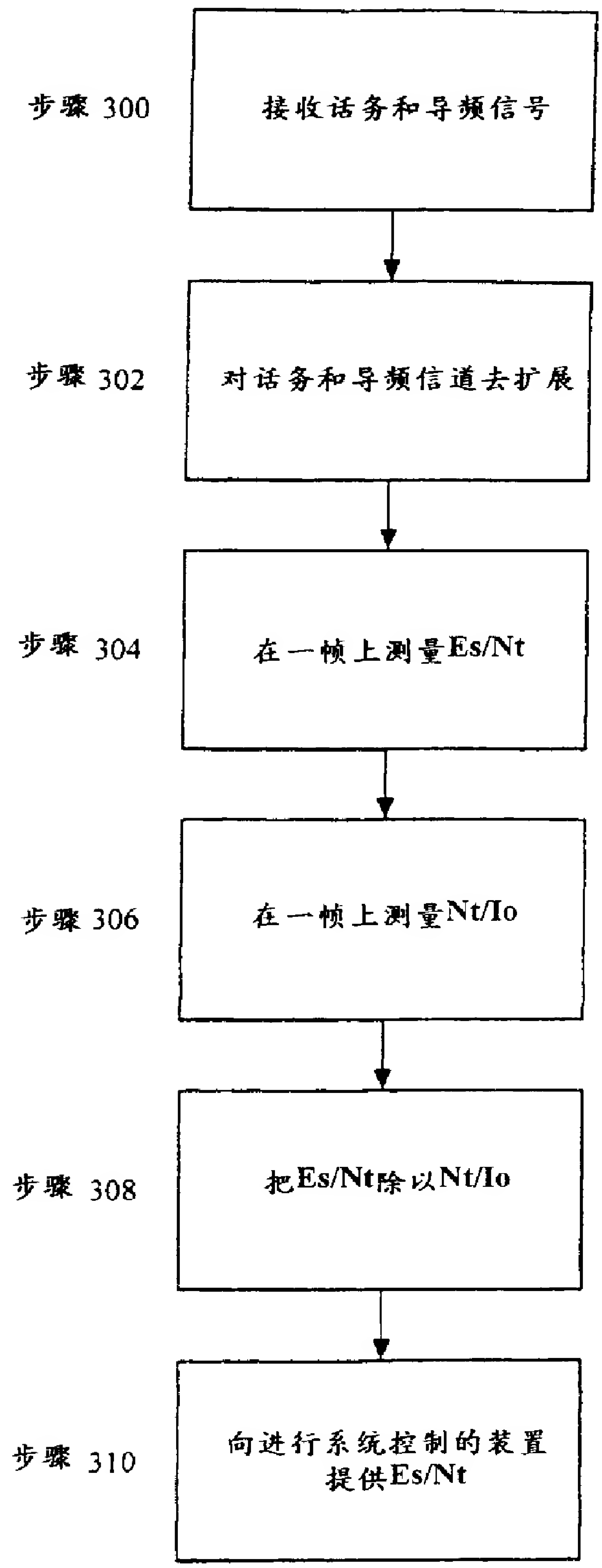

步骤 300
接收话务和导频信号
步骤 302
对话务和导频信道去扩展
步骤 304
在一帧上测量Es/Nt
步骤 306
在一帧上测量Nt/Io
步骤 308
把Es/Nt除以Nt/Io
步骤 310
向进行系统控制的装置提供Es/Nt

图 3

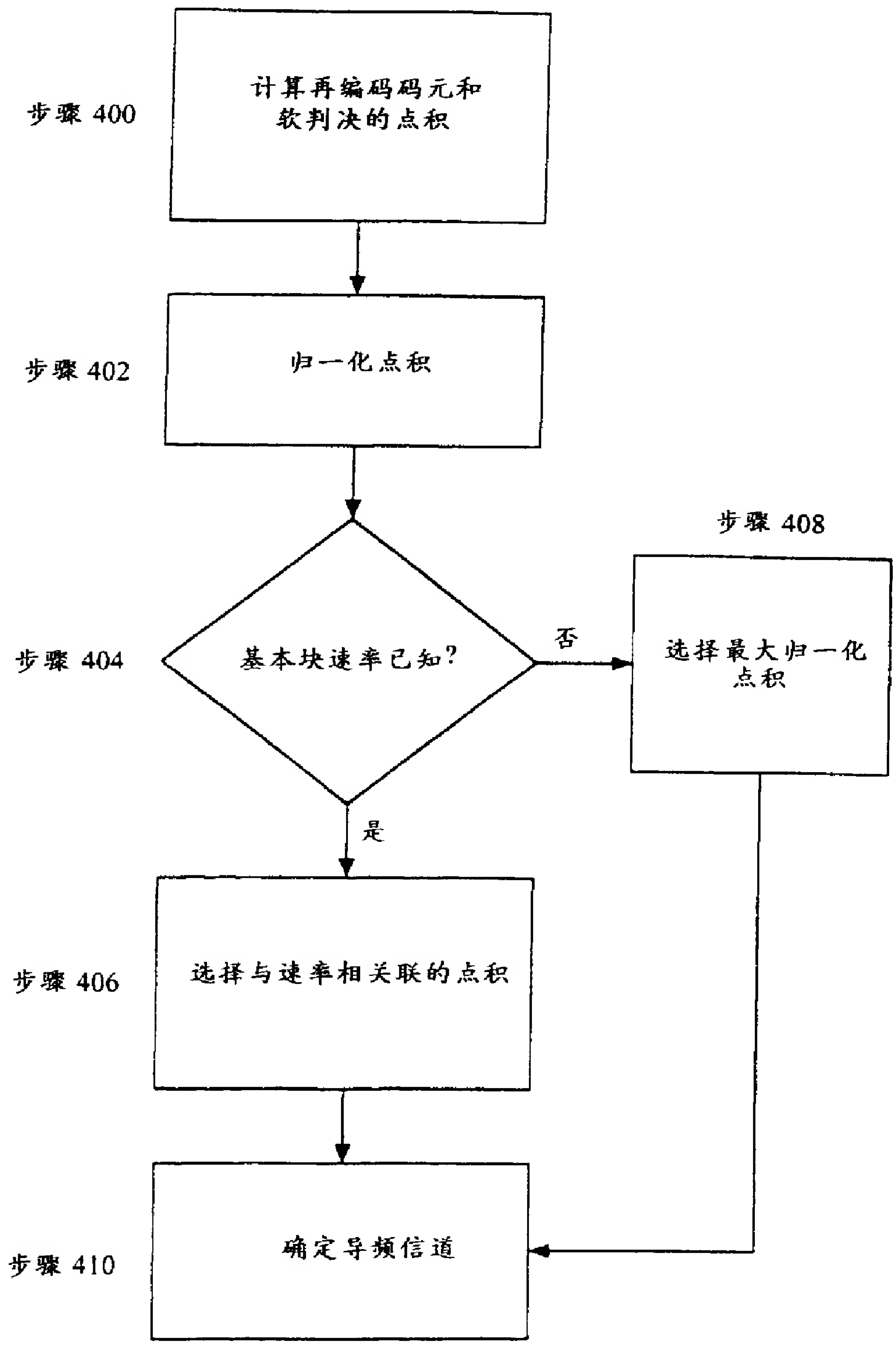

步骤 400
计算再编码码元和
软判决的点积
步骤 402
归一化点积
步骤 404
基本块速率已知?
否
是
步骤 408
选择最大归一化
点积
步骤 406
选择与速率相关联的点积
步骤 410
确定导频信道

图 4

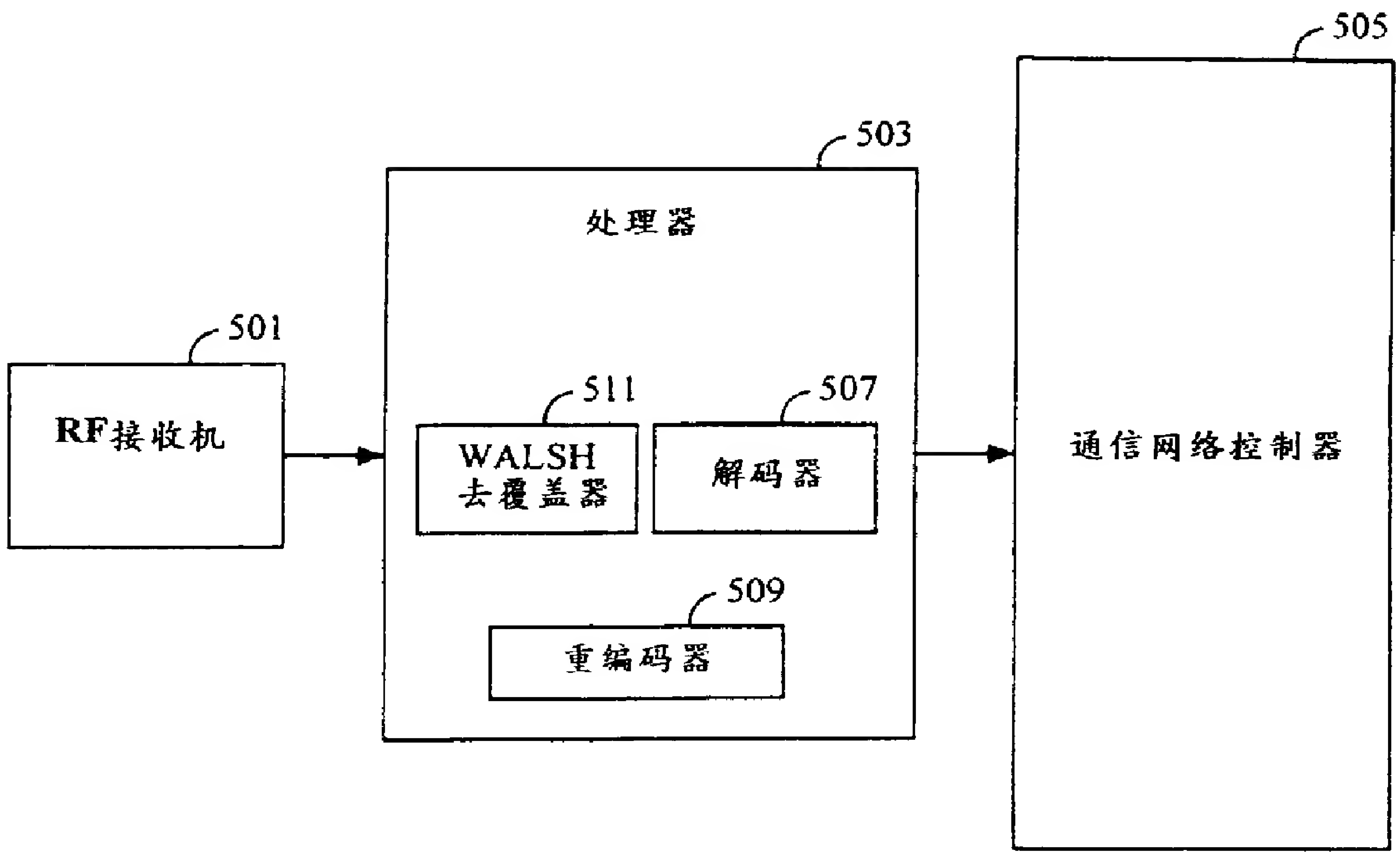


图 5

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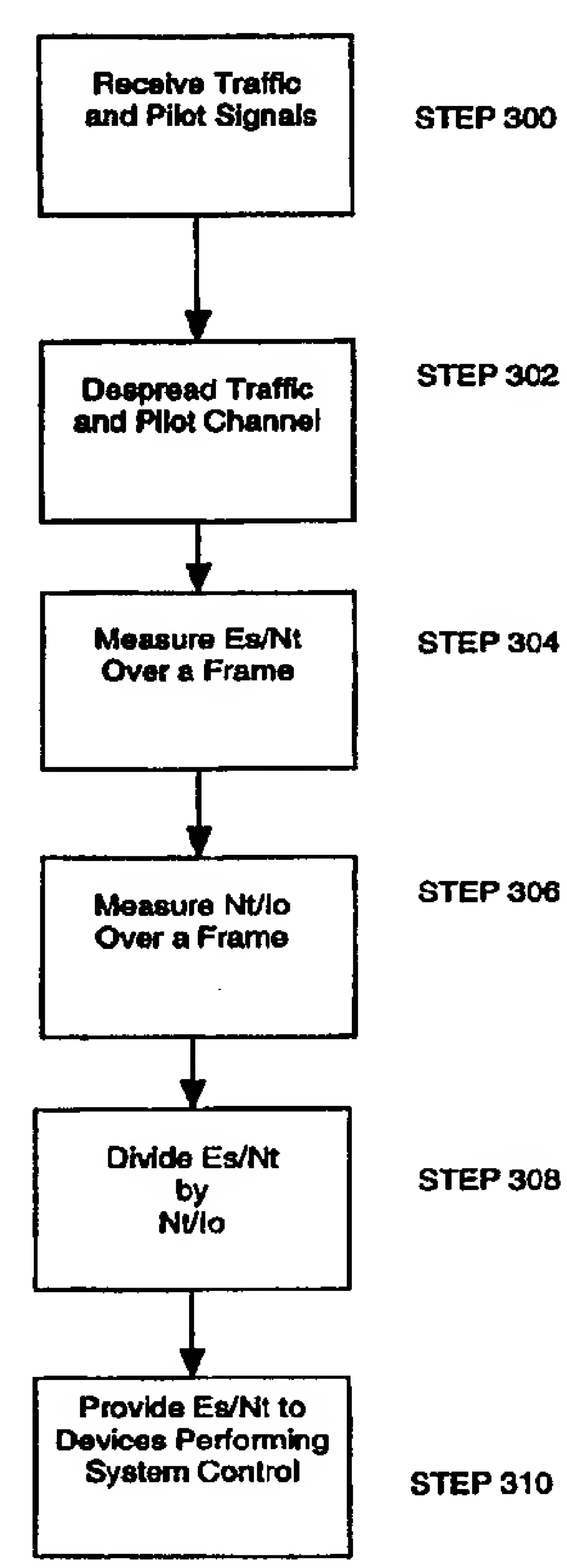
(54) Title: FORWARD LINK POWER CONTROL IN A CELLULAR SYSTEM USING N_T/I_0 VALUES

(57) Abstract

A system and method is taught for controlling the power level of transmissions within a communication system having a base station, a mobile station, a communication channel, and a pilot channel. The mobile station determines a signal strength value according to a communication signal received by way of the communication channel. A pilot channel signal is determined according to a pilot signal transmitted by way of the pilot channel. The signal to noise ratio of the communication signal is determined according to the determined signal strength value and the pilot channel signal. The power level of a transmission is controlled according to the signal to noise ratio. The noise level in a communication channel within the communication system is estimated. The pilot channel signal includes pilot energy and pilot noise components. The pilot energy component is removed to provide a remaining pilot signal. Communication system operations are controlled according to the remaining pilot signal. The power levels of transmissions are controlled by determining the signal to noise ratio of a signal within the communication channel and determining a difference signal. The difference signal is formed by determining the difference between determined and desired signal to noise ratios. The difference signal is transmitted between the base station and the mobile station. The pilot channel has at least one frame and the power control signal is inserted into the frame. Thus, information representing the strength of the communication signal is transmitted to the base by way of the pilot channel within the frame. The pilot channel can have two information frames for transmitting the power control signal a plurality of times.



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FORWARD LINK POWER CONTROL IN A CELLULAR SYSTEM USING N_T/I_0 VALUES

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to communications systems in general, and to power control in a communications system in particular.

II. Description of the Related Art

There are many in prior art communications systems that require a measurement of the strength of a signal received by a mobile station. For example, during handoff of a mobile station from one base station to another a determination of the strength of the signals received by the mobile station is desirable for determining when to perform the handoff. One such handoff technique is disclosed in U.S. Patent No. 5,267,261, entitled "MOBILE STATION ASSISTED SOFT HANDOFF IN A CDMA CELLULAR COMMUNICATIONS SYSTEM," assigned to the assignee of the present invention.

In the improved technique of U.S. Patent No. 5,267,261 the mobile station monitors the signal strength of pilot signals transmitted by neighboring base stations within the system. The mobile station sends a signal strength message to a system controller via the base station through which the mobile station is communicating. Command messages from the system controller to a new base station and to the mobile station in response to the signal strength are thus used to establish communication through the new and current base stations. The mobile station detects when the signal strength of a pilot corresponding to at least one of the base stations through which the mobile unit is currently communicating has fallen below a predetermined level. The mobile station reports the measured signal strength indicative of the corresponding base station to the system controller via the base stations through which it is communicating. Command messages from the system controller to the identified base station and mobile station terminate communication through the corresponding base station while communications through the other base station or stations continue.

It is known for the power control information transmitted from the mobile station to be inserted into a dedicated control channel separate from the traffic channel. However it is desirable to decrease the need for separate control channels. Additionally, while it is preferably for the power of the energy of the signal sent on the traffic channel to be used to determine the power control parameters, it is known for the control information to be based upon the error rate rather than the signal to noise ratio because the signal to noise ratio of the traffic channel is difficult to measure. For example, in some current systems, the time between errors is used to indicate the error rate. The error rate is then used to determine the quality of the traffic channel. Furthermore, it is difficult to obtain power control information and utilize it in time to respond to the conditions indicated in the power control information.

SUMMARY OF THE INVENTION

A system and method is taught for estimating the relative amount of power that is provided on the traffic channel using a calculated amount of noise that is present on a pilot channel. This estimate may then be used for several purposes, including controlling the power level of transmissions within a communication system having a base station, a mobile station and a plurality of channels including a communication channel and a pilot channel. The mobile station measures the ratio of the amount of energy received per symbol to the amount of interference received. The amount of energy received over the pilot channel is used to determine the amount of noise received in the pilot channel. The signal to noise ratio of the communication signal is determined according to the determined signal strength value and the pilot channel noise value. Accordingly, in one embodiment of the disclosed method and apparatus, the power level of a transmission is controlled according to the calculated signal to noise ratio.

A system and method is also taught for estimating the noise level in a communication channel within the communication system. The pilot signal includes a pilot energy component and a pilot noise component. The pilot energy component is removed from the pilot channel signal to provide a

remaining pilot signal. As noted above, the amount of noise in the channel is estimated based upon the amount of noise in the pilot channel.

As noted above, in accordance with systems, the power of transmitted signals is controlled based upon an indication of the amount of power received by the intended receiving device. In such systems, the power levels of transmissions are controlled by determining difference between the signal to noise ratio of a received signal and the desired signal to noise ratio. A transmitter transmits the difference signal between the base station and the mobile station.

The pilot channel is divided in time into frames and the power control signal is inserted into each frame. Thus, information representative of the strength of the communication signal is transmitted to the base station by way of the pilot channel within each frame.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 shows an exemplary illustration of a cellular communication system;

FIG. 2 shows a power control subchannel within the cellular communication system of Fig. 1;

FIG. 3 is a flow chart illustrating the steps performed to determine signal to noise ratio of a received traffic signal;

FIG. 4 is a detailed flow chart illustrating certain steps of FIG 3; and

FIG. 5 is a block diagram of the disclosed apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An exemplary illustration of a cellular communication system is provided in FIG. 1. The system illustrated in FIG. 1 can use various multiple access modulation techniques for facilitating communications between a large number of system mobile stations (or mobile communication devices), and the base stations. These techniques include CDMA spread spectrum modulation.

In a typical CDMA system, the base stations transmit a unique pilot signal including a pilot carrier upon a corresponding pilot channel. For example, in accordance with one embodiment of the disclosed method and apparatus, the pilot signal is an unmodulated, direct sequence, spread spectrum signal transmitted at all times by each base station using a common pseudorandom noise (PN) spreading code. The pilot signal allows the mobile stations to obtain initial system synchronization, in addition to providing a phase reference for coherent demodulation and a reference for signal strength measurements. Furthermore, the received pilot signal can be used to estimate the arrival time, phase and amplitude of the received traffic signal. In accordance with one embodiment of the disclosed method and apparatus, the pilot signal transmitted by each base station is modulated with the same PN spreading code with different code phase offsets.

A system controller 10, also referred to as a mobile switching center (MSC) 10, typically includes interface and processing circuitry for providing system control to the base stations. The controller 10 also controls the routing of communication device calls from the networks (such as the public switched telephone network (PSTN)) to the appropriate base station for transmission to the appropriate mobile station. The routing of calls from mobile stations through base stations to the PSTN is also controlled by the controller 10.

The controller 10 can be coupled to the base stations 12, 14, 16 by various means such as dedicated phone lines, optical fiber links or by microwave communication links. In FIG. 1, three base stations 12, 14, 16 and a communication device (such as a mobile station) 18 are illustrated. The mobile station 18 consists of at least a receiver, a transmitter, and a processor. The base stations 12, 14, 16 typically include processing circuitry for controlling the

functions of the base stations 12, 14, 16, and interface circuitry for communicating with both the mobile station 18 and the system controller 10.

The Arrows 20A-20B shown in FIG. 1 represent the possible communication link between the base station 12 and the mobile station 18. The Arrows 22A-22B shown in FIG. 1 represent the possible communication link between the base station 14 and the mobile station 18. Similarly, the arrows 24A-24B shown in FIG. 1 represent the possible communication link between the base station 16 and the mobile station 18.

After a mobile station 18 processes a received signal, the resulting signal is a composite of a desired signal and a noise signal. The signal to noise ratio averaged over some period of time is a good measure of the strength of the received signal. For example, in a CDMA system the signal to noise ratio of the received signal can be averaged over a block. The mobile station 18 can, therefore, estimate the signal to noise ratio and compare the estimate with the value the mobile station 18 actually received. In accordance with one embodiment of the disclosed method and apparatus, the mobile station 18 sends to the base stations 12, 14, 16 the resulting difference between the measured and expected values of the signal to noise ratio as a parameter (FWD_SNR_DELTA) represented in units of decibels. The parameter (FWD_SNR_DELTA) is preferably transmitted on a reverse link power control subchannel.

In determining the expected signal to noise ratio, the mobile station 18 calculates a signal to noise ratio that will result in an average forward link fundamental block erasure rate equal to the forward link fundamental block erasure rate configured by the base stations 12, 14, 16. In calculating the expected signal to noise ratio, the mobile station 18 assumes that successively lower rate blocks are transmitted with three decibels less power per PN chip. In accordance with one embodiment of the disclosed apparatus, the mobile station 18 performs maximal ratio combining of the receive paths.

In addition to calculating the expected signal to noise ratio, the mobile station 18 must determine the signal to noise ratio of the received traffic signal. The flowchart of Figure 3 is a high level flowchart that illustrates the steps that are performed in order to determine the signal to noise ratio of the received

traffic signal. Initially, the traffic and pilot signals are received (together with any noise on the channel) (STEP 300). While filters remove noise that is out of the frequency band over which the traffic and pilot signals are transmitted, noise that is in-band, is passed. The received traffic signal is decover by the particular Walsh code used to channelize the traffic channel. Likewise, the pilot channel is decover by the particular Walsh code used to channelize the pilot channel (STEP 302). Once the pilot and traffic channels have been decover, the per symbol signal to interference E_S/I_o is measured (STEP 304). Next, the noise to interference, N_t/I_o is measured (STEP 306). Once these values are measured, the per symbol signal to interference, E_S/I_o is divided by the N_t/I_o to yield the per symbol to noise ratio, E_S/N_t (STEP 308). This value is then provided to devices that use the per symbol to noise ratio E_S/N_t to control the system (STEP 310), such as by performing power control of the forward link transmit signal. The details as to how STEPs 304 and 306 are performed are provided in the flowchart in FIGURE 4.

It should be understood by those skilled in the art that prior to decovering to separate the orthogonal channels, each of the traffic channels is included in the noise on the pilot channel. Likewise, the pilot signal and each of the traffic channels, except the traffic channel of interest, are included in the noise of the traffic channel of interest. Once decovered, the noise in the traffic channel includes only energy associated with non-orthogonal signals. It should further be understood by those skilled in the art that an automatic gain control device is typically used to ensure that the total received signal is received at an essentially constant value. Accordingly, all of the signal values are referenced to the total received signal strength, I_o. Nonetheless, this is not noted in the equations that follow. Accordingly, the total received traffic signal can be represented as:

$$r_T = s_T + n_T \qquad \textbf{EQN. (1)}$$

where s_T represents the desired traffic signal and n_T represents the noise in the received traffic signal. It will be understood that:

$$s_T = \Sigma d_k \, E_{s,k}{}^{1/2} \qquad \textbf{EQN. (2)}$$

where d_k is the k^{th} symbol within the symbol stream or data stream of the traffic channel; and $E_{T,k}$ is the total received energy of the traffic channel over a symbol. The sum is taken for all k from 1 to n, where n is the total number of symbols in a frame. It should be noted that in an alternative embodiment of the disclosed method and apparatus, the number of symbols, n may differ from the number of symbols in a frame.

In many cases, a "rake" receiver is used to combine signals received from different sources or signals from the same source that have traversed different paths (and thus are delayed with respect to one another). In such cases, the total received traffic signal is attained by multiplying the traffic signals received on each independent path by the associated pilot signals. This multiplication results in each received traffic signal being weighted by the relative strength of the associated pilot signal. These products are then summed to form the total received traffic signal r_T. The following equation represents this sum:

$$r_T = \Sum r_{T,i} \langle r_{p,i} \rangle \qquad \textbf{EQN. (3)}$$

where the sum is taken over the subscript i from 1 to m, $r_{T,i}$ is the received traffic signal for the i^{th} path, m is the total number of paths, and the brackets which enclose the term $r_{p,i}$ indicate the fact that the pilot signal may be filtered by a low pass filter to reduce any fluctuations in the amplitude of the pilot over short periods in time.

The total received pilot signal for a particular path can be represented as:

$$r_{P,i} = s_{P,i} + n_{P,i} \qquad \textbf{EQN. (4)}$$

where s_P represents the received pilot signal and n_P represents the pilot noise.

In addition, the pilot signal value $s_{p,i}$ is equal to the data times the square root of the energy per symbol, E_s and a scaling factor. This relationship can be represented as follows:

$$s_{P,i} = \alpha\Sigma(d_k E_{S,k}^{1/2}) \qquad \textbf{EQN. (5)}$$

where: α is a scaling factor which takes into account the relative transmission gains of the traffic and pilot channels and the integration lengths for each channel; the sum is taken over the subscript k from 1 to n; n is the total number of symbols; d_k is the k^{th} symbol of the symbol stream or data stream of the pilot channel; and $E_{S,k}$ is the total received energy of the pilot channel over the k^{th}

symbol. The symbol stream d is essentially either a positive one or a negative one representing the state of the information modulated on the pilot channel. In the case of the pilot signal, it is typical for the data to have a constant value of one. Therefore, the data, d can be dropped from the equation. In multiplying a traffic signal with a pilot signal, Eqn. (2) can be substituted into Eqn. (1), and Eqn. (5) can be substituted into Eqn. (4). The resulting produce is then:

$$r_T = [(\Sigma d_k\, E_{S,k}{}^{1/2})_i + n_{T,i}\,] \bullet [\alpha\Sigma(d_k E_{S,k}{}^{1/2})_i + n_{p,i}] = d\alpha E_S + \text{noise} \qquad \textbf{EQN. (6)}$$

However, if the noise n_P of the pilot signal r_P and the noise n_T of the traffic signal r_T are uncorrelated, then the product r_T is essentially a scaled unbiased estimator of the traffic data multiplied by the traffic signal energy. This is due to the fact that the uncorrelated noise will not sum up. However, the correlated data does sum up. Accordingly, an assumption can be made that the noise is negligible (i.e., insignificant and can be ignored). It can reasonably be assumed that the noise n_P of the pilot signal r_P and the noise n_T of the traffic signal r_T are uncorrelated, because the pilot signal r_P and the traffic signal r_T are transmitted on orthogonal channels.

Since d is essentially random and unknown, it is desirable to eliminate d from Eqn. (6). In accordance with the disclosed method and apparatus, in order to eliminate d from Eqn. (6), a dot product is performed. The dot product is taken between the estimator $d\alpha E_T$ and the symbol stream d after decoding and re-encoding of the received traffic signal (STEP 400). By decoding the traffic information, the information is essentially extracted from the received signal. Re-encoding the information returns the information to the state in which it existed before the decoding. Since the data sequence is relatively well known after the decoding operation, performing this dot product allows the data sequence to be taken into account when determining the energy of the received signal. That is, the dot product projects the data onto the received signal. Accordingly, the energy in the information symbols is summed and the energy in the noise is not, since the noise is uncorrelated. Naturally, the more symbols are summed, the greater the ratio of symbol energy to noise. The result of the dot product operation is:

$$\alpha E_T \bullet \alpha E_T = (\alpha E_T)^2 \qquad \textbf{EQN. (7)}$$

In order to estimate the traffic channel signal energy, the scaling factor α is removed from Eqn. (7). Scaling factor α can be represented as:

$$\alpha = G_P/G_T \bullet L_P/L_T \qquad \textbf{EQN. (8)}$$

where G_P is the pilot signal transmission gain, G_T is the traffic transmit signal transmission gain, L_P is the integration period of the pilot signal, and L_T is the integration period of the traffic signal. While the pilot integration period L_P and the traffic integration period L_T are known, the relationship between the pilot signal gain G_P and the traffic transmit signal gain G_T is typically not known in cases in which power control factors change the gain of the traffic channel.

Therefore, in order to eliminate the scaling factor α, the mobile station 18 determines the pilot energy by computing the dot product of the pilot signal with itself. This produces a biased estimate of the pilot energy E_P which is a scaled biased estimate of the signal energy, $E_P = \alpha^2 E_T$. Therefore, a biased estimate of the traffic signal energy E_T can be determined by squaring the unbiased estimator, αE_T of the traffic signal energy and dividing it by the biased estimator of the pilot signal energy E_P:

$$E_T = (\alpha E_T)^2 / (\alpha^2 E_T) \qquad \textbf{EQN. (9)}$$

As noted above in Eqn. (7), the energy per symbol, E_S can then be attained by normalizing the value E_T with respect to a symbol (i.e., by dividing by the number of symbols over which E_T was determined, such as the number of symbols per frame) (STEP 402). Accordingly:

$$E_T / n = E_S \qquad \textbf{EQN. (10)}$$

where n is the number of symbols over which E_T was determined.

If the fundamental block rate of the received traffic signal is known (STEP 404), then the normalized dot product associated with the block rate is selected (STEP 406). However, if the fundamental block rate is not known (STEP 404), then the dot product that has the maximum value is selected (STEP 408).

The disclosed method and apparatus takes advantage of the fact that the pilot signal has a known constant data sequence. Since the data sequence is

known, the pilot channel signal can be easily differentiated to isolate the noise content (STEP 410). In accordance with one embodiment of the disclosed method and apparatus, this is done by inverting the pilot channel, shifting the inverted pilot channel signal one symbol in time with respect to the unshifted pilot channel signal, and summing the shifted inverted pilot channel signal with the unshifted pilot channel signal. This can also be done by decovering the pilot channel with Walsh code W_{64}^{128} and integrating over the frame. This particular Walsh code is a pattern of alternating positive ones and negative ones. Thus, the sum of the energy in the pilot channel over a discrete number of symbols is zero, thereby isolating the remaining N_T term. This permits a determination of the normalized noise of the pilot channel.

The desired value, which is the signal to noise ratio is E_S/N_T, can be attained by simply dividing the value E_S by the value N_T.

Figure 5 is a simplified block diagram of the disclosed apparatus. A radio frequency (RF) receiver 501 receives the incoming signal and does RF processing in known fashion. The received signal is then coupled to a processor 503. A Walsh decovering circuit 511 within the processor 503 decovers each of the traffic channels and the pilot channel. It will be understood by those skilled in the art that the Walsh decovering circuit 511 may be implemented either as software run on the processor 511, as a circuit which is implemented using discrete components, an application specific integrated circuit (ASIC) which is distinct from the processor 511, or in any other manner that would allow the decovering procedure to be accomplished, as is well known in the art. Once decovered, the traffic channel signal is coupled to a decoder 507. Similar to the decovering circuit, the decoder 507 may be implemented using discrete components, an application specific integrated circuit (ASIC) which is distinct from the processor 511, or in any other manner that would allow the decoding procedure to be accomplished, as is well known in the art. The decoding process results in the information that was originally encoded by the transmitter that transmitted the received signal. This information is then coupled to a re-encoder 509. The re-encoder 509 may be implemented using discrete components, an application specific integrated circuit (ASIC) which is distinct from the processor 511, or in any other manner that would allow the re-

encoding procedure to be accomplished, as is well known in the art. Once the re-encoding function has been performed, the processor 503 performs the functions described above to determine the E_S/N_T value. This value is then coupled to a communication network controller 505, such as the processor within a base station that is responsible for controlling the forward link power control, or the processor within a mobile cellular telephone that is responsible for communicating the amount the forward link power control should be adjusted in order to maintain a desired transmission power. It should be noted that the particular use to be made of the E_S/N_T value is not intended to be limited by the particular embodiments that are disclosed herein, but should be understood to include all possible applications of this quality value.

The mobile station 18 can also calculate the measured normalized signal to noise ratio, E_f/N_t, on a per frame basis. The normalized per frame signal to interference ratio E_f/R is measured, where R is the total signal received and E_f is the energy of the desired signal during a single frame. The per frame noise to interference ratio, N_t/R, is then measured. E_f/I_0 is then divided by N_t/R in order to calculate E_f/N_t.

The normalized per frame signal to noise ratio, E_f/N_0 used to calculate the normalized per frame signal can be calculated as follows. The dot product of the re-encoded symbols d and the soft decisions $d\alpha E_T/I_0$ can be computed for each rate of the fundamental block. The result can be squared and divided by the estimated pilot energy as shown:

$$E_P/I_0 = \alpha^2 E_T/I_0 \qquad \textbf{EQN. (11)}$$

The dot products for each rate of the fundamental block can be normalized using the ratio of the number of symbols in a full rate block to the number of symbols in the block. If the fundamental block rate is not known the maximum normalized dot product can be selected. The per frame noise to interference ratio, N_t/I_0 can then be measured by accumulating the energy in a forward code channel over the frame.

Signals representative of the signal to noise ratio can be used for the control of power transmission levels in the system and method of the present invention. In the preferred embodiment of the invention for example, the base

stations 12, 14, 16 can use the FWD_SNR_DELTA value sent to it by the mobile station 18. The FWD_SNR_DELTA value is sent to the base stations by the mobile station 18 on the power control subchannel of a reverse frame n to adjust the forward gain (FWD_GAIN) it applies to a forward frame n+1.

In order to calculate FWD_SNR_DELTA the mobile station 18 can use an expected signal to noise value along with the calculated signal to noise value. The per frame expected signal to noise ratio E_f/N_t can be calculated as follows. The mobile station 18 can set the initial expected value equal to the ratio of the first fundamental block that it successfully decodes. If the fundamental block is erased the mobile station 18 increases the expected value of E_f/N_t. Otherwise, the mobile station 18 decreases the expected value of E_f/N_t.

The increase step size P_i and the decrease step size P_d are determined by the desired forward link fundamental block erasure rate R_e and the maximum rate of increase of E_f/N_t. This maximum rate of increase can be defined as P_m. Then, $P_d = (R_e P_m)/(R_e-1)$ and $P_i = (P_d / R_e)$. P_m can have a value of one-half.

If the power control subchannel FWD_SNR_DELTA is not erased by the base stations 12, 14, 16, the forward per symbol signal to noise ratio delta flag (FWD_SNR_VALID) is set to 1. Otherwise, the base stations 12, 14, 16 set both the FWD_SNR_DELTA and FWD_SNR_VALID values to 0. The forward gain applied by the base station transmitter to forward transmit frame n+1 is then calculated as follows:

$$\text{FWD\_GAIN}[n+1] = \begin{cases} \text{FWD\_GAIN\_MIN}, & \text{where } \text{FWD\_GAIN}_{adj} < \text{FWD\_GAIN\_MIN} \\ \text{FWD\_GAIN\_MAX}, & \text{where } \text{FWD\_GAIN}_{adj} > \text{FWD\_GAIN\_MAX} \\ \text{FWD\_GAIN}_{adj}, & \text{otherwise} \end{cases} \quad \textbf{EQN. (12)}$$

where $\text{FWD\_GAIN}_{adj} = \text{FWD\_GAIN}[N]*10^{-X}$, and superscript X is determined according to FWD_SNR_DELTA and FWD_SNR_VALID. It will be understood, however, that any method of calculating FWD_GAIN can be used in accordance with the system and method of the present invention.

Referring now to FIG. 2, there is shown a portion of power control subchannel 30. Power control subchannel 30 is suitable for use in the communication system of FIG. 1. For example, power control subchannel 30 can be used to transmit FWD_SNR_DELTA from the mobile station 18 to the

base stations 12, 14, 16 in order to control the power level of transmissions to the mobile station 18.

Power control subchannel 30 can be located within a pilot channel carrying a plurality of power control groups 34. For example, sixteen power control groups 34 can form each of a plurality of frames 38 within the pilot channel. Each power control group 34 can contain a plurality of pseudorandom noise words 38. In practicing the method of the present invention one or more pseudorandom noise words 38 can be removed and replaced with power control information 40.

The removed pseudorandom noise words 38 can be any noise words 34 within the length of power control group 34. However, in a preferred embodiment, noise words 38 located towards the center of power control group 34 are used. It is preferred that power control information 40 instruct a transmitter to increase or decrease the transmit power level a specified amount or to leave the transmit power level unchanged, as shown in Eqn. (12). Furthermore, it is also preferred that the transmission of frame 38 containing power control information 40 in this manner be repeated several times in order to increase reliability.

It will be understood that any power control information can be transmitted by puncturing the power control information into selected positions within a power control group 34. In addition, it will be understood that this method of puncturing power control information into the pilot channel may be advantageously applied to any of the methods for determining power control information set forth herein.

The foregoing description of the preferred embodiments of this invention is provided to enable a person of ordinary skill in the art to make and use the invention claimed herein. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the principles described can be applied to other embodiments without the use of any inventive faculty. Therefore, the present invention is not to be limited to the specific embodiments disclosed but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

CLAIMS

1. A method for determining signal to noise ratio transmissions received within a communication system including a communication channel and a pilot channel, comprising the steps of:

(a) measuring the per symbol signal to interference ratio over a predetermined amount of time;

(b) measuring the noise to interference ratio over a second predetermined amount of time;

(c) dividing the measured per symbol signal to interference ratio by the measured noise to interference ratio; and

(d) providing the quotient to a network controller.

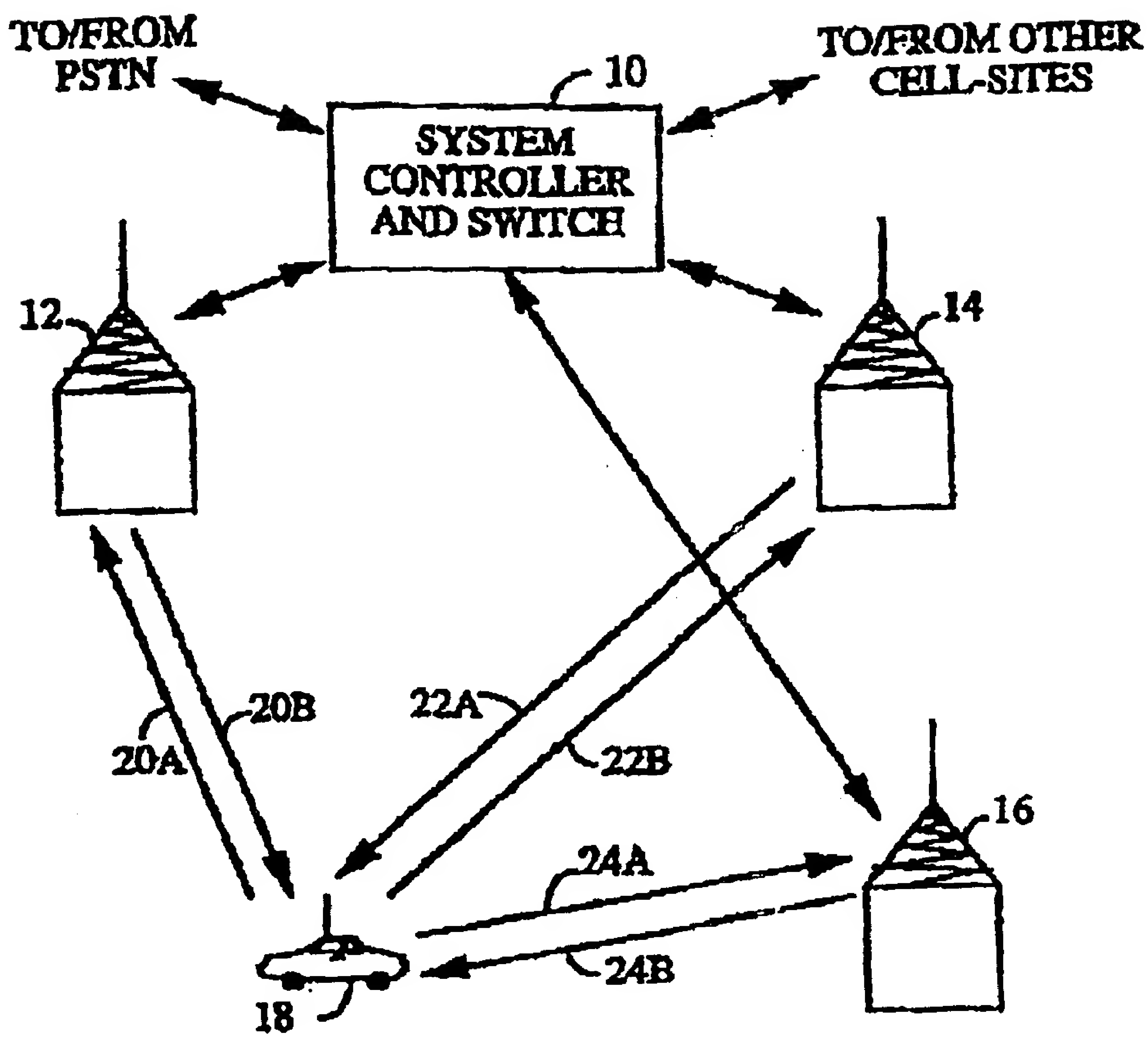
2. A system for controlling the power level of transmissions within a communication system having a base station, a mobile station and a plurality of channels including a communication channel and a pilot channel, comprising:

(a) a signal strength value determined by the mobile station according to a communication signal received by way of the communication channel;

(b) a pilot channel signal determined according to a pilot signal transmitted by way of the pilot channel;

(c) signal to noise ratio of the communication signal determined according to the signal strength value and the pilot channel signal; and

(d) a transmitter for controlling the power level of a transmission according to the signal to noise ratio.



TO/FROM PSTN
10
SYSTEM CONTROLLER AND SWITCH
TO/FROM OTHER CELL-SITES
12
14
20A
20B
22A
22B
16
24A
24B
18

FIG. 1

30

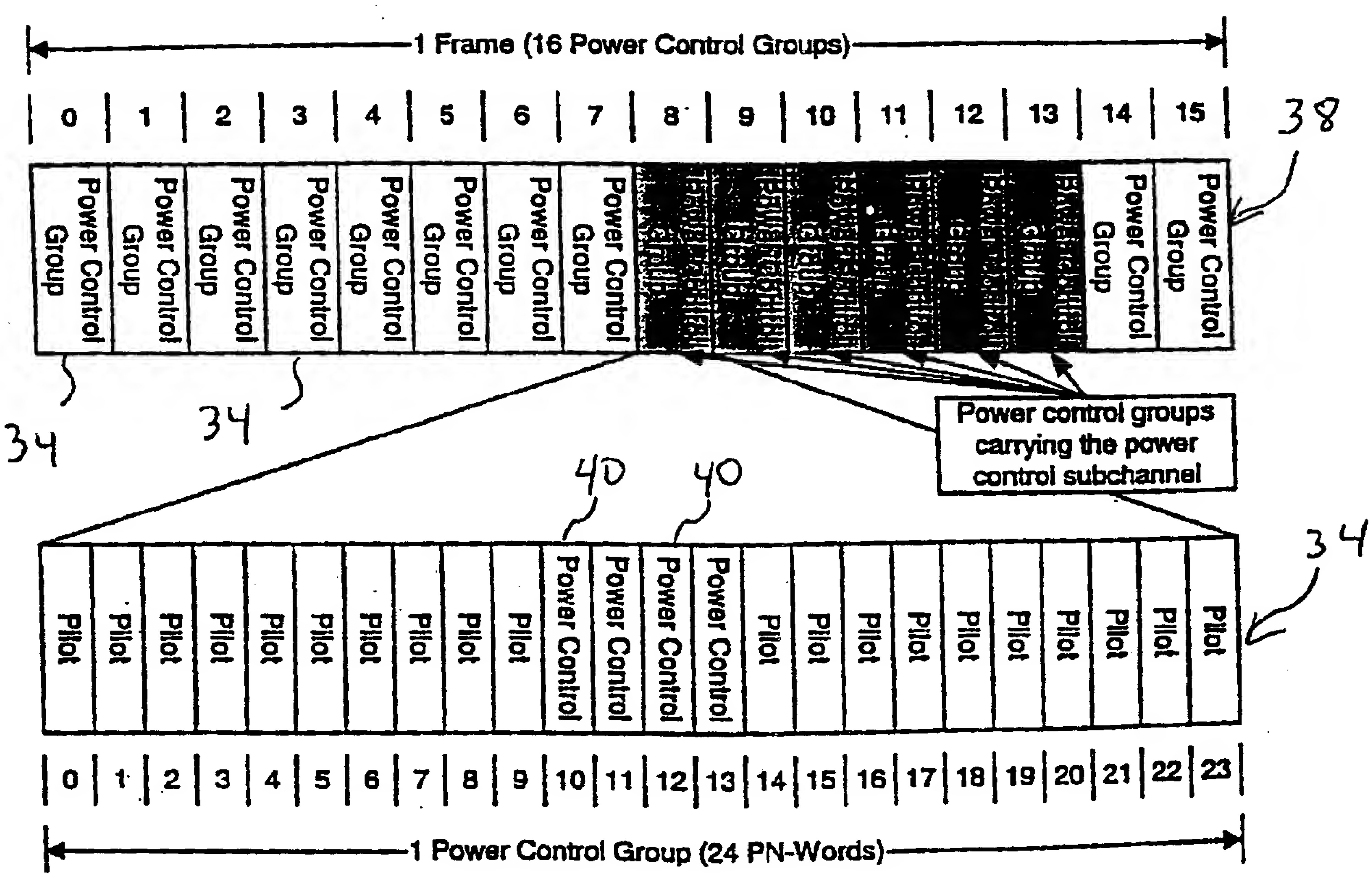

1 Frame (16 Power Control Groups)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Power Control Group
38
34
34
Power control groups carrying the power control subchannel
40
40
34
Pilot
Power Control
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1 Power Control Group (24 PN-Words)

FIG. 2

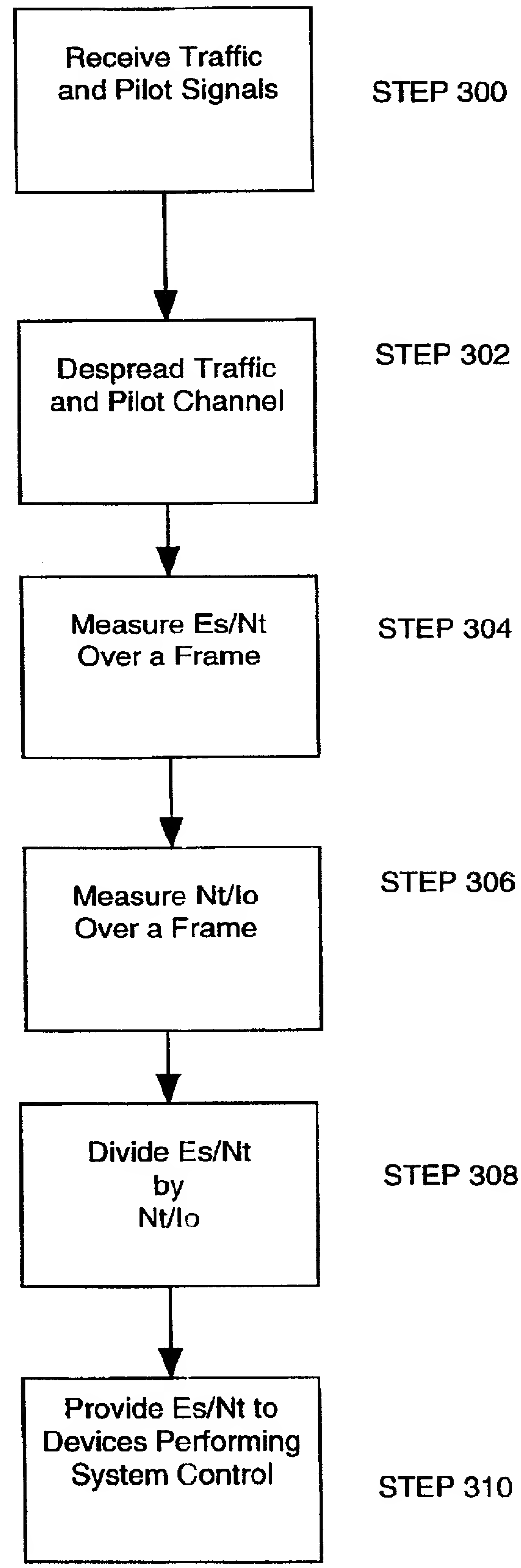
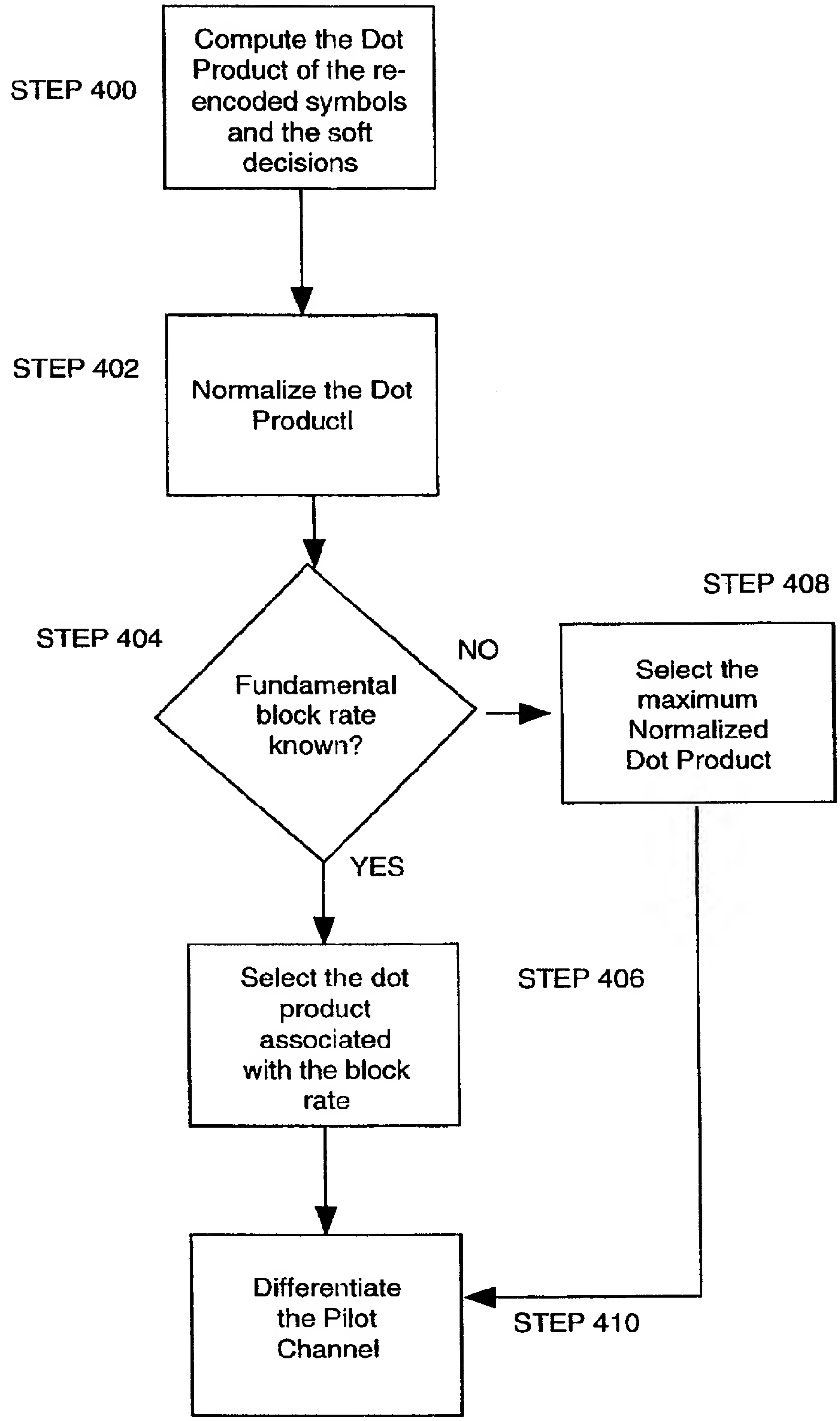

Receive Traffic and Pilot Signals
STEP 300
Despread Traffic and Pilot Channel
STEP 302
Measure Es/Nt Over a Frame
STEP 304
Measure Nt/Io Over a Frame
STEP 306
Divide Es/Nt by Nt/Io
STEP 308
Provide Es/Nt to Devices Performing System Control
STEP 310

FIGURE 3

FIGURE 4


STEP 400
Compute the Dot Product of the re-encoded symbols and the soft decisions
STEP 402
Normalize the Dot Productl
STEP 404
Fundamental block rate known?
NO
YES
STEP 408
Select the maximum Normalized Dot Product
STEP 406
Select the dot product associated with the block rate
STEP 410
Differentiate the Pilot Channel

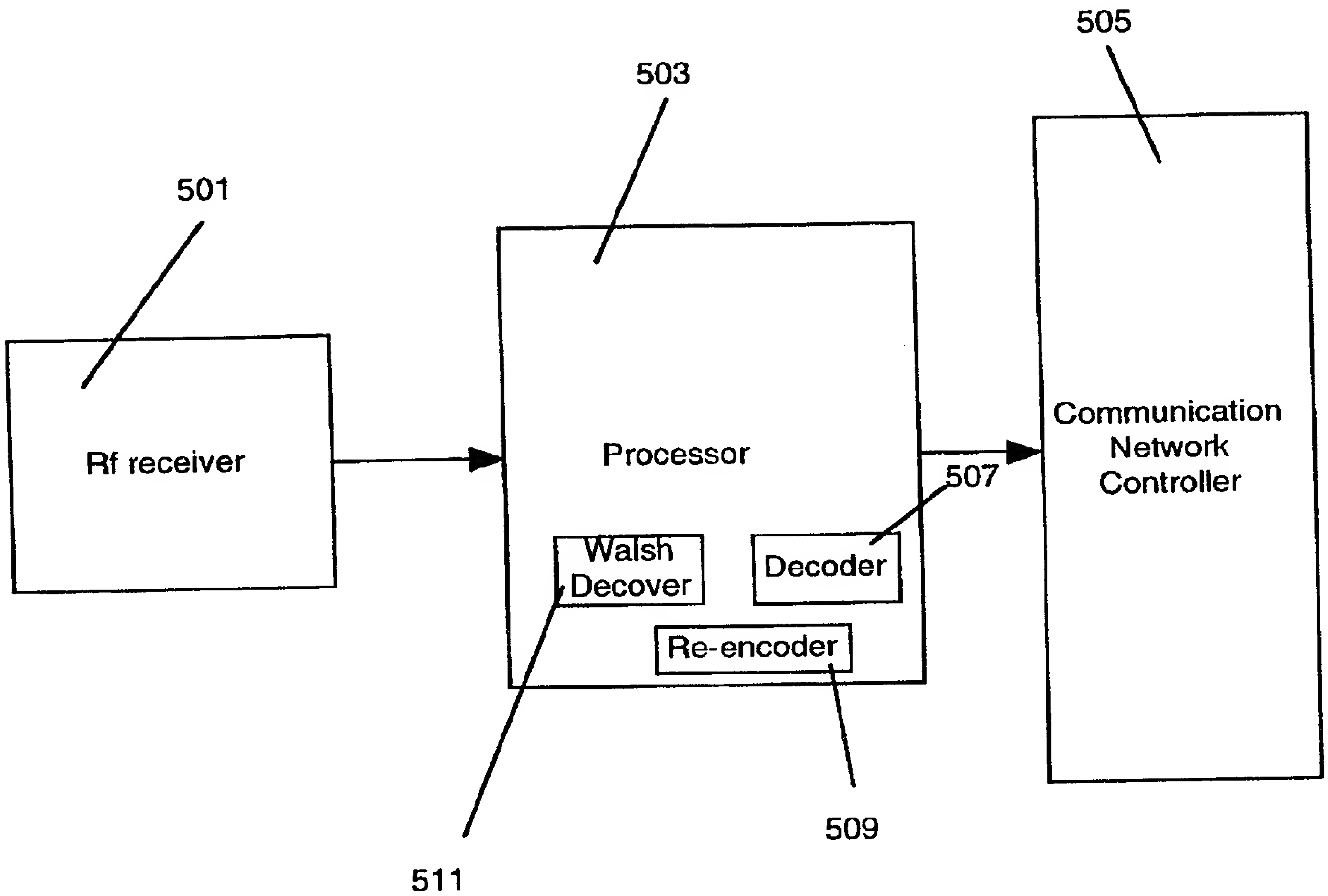

505
503
501
Rf receiver
Processor
Communication
Network
Controller
507
Walsh
Decover
Decoder
Re-encoder
509
511

FIGURE 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/03683

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/005 H04B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 98 02981 A (ERICSSON) 22 January 1998 see page 8, line 10 - page 18, line 30	2 1
Y	US 5 697 053 A (HANLY) 9 December 1997 see column 3, line 36 - column 6, line 58; figures	2
A	WO 97 34439 A (QUALCOMM) 18 September 1997 see page 20, line 7 - page 42, line 23; figures	1,2
A	WO 97 02665 A (ITC) 23 January 1997 see page 5, line 8 - page 23, line 3; figures	1,2
A	EP 0 680 160 A (NTT) 2 November 1995 see page 4, column 6, line 2 - page 6, column 9, line 20; figures	1,2
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 June 1999	25/06/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Geoghegan, C

1

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 12297 A (QUALCOMM) 4 May 1995 see page 10, line 1 - page 22, line 11; figures -----	1,2

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/03683

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